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Original Research Article

Evaluation of correlation between impacted maxillary canine, transverse maxillary deficiency, and posture of tongue

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Abstract

Background: The position and eruption of maxillary canines is essential for dental occlusion and facial aesthetics. However, the relationship between impacted maxillary canines, transverse maxillary deficiency, and tongue posture is unclear. Understanding these correlations can provide valuable insights into orthodontic treatment planning and the management of impacted canines. Therefore, this study aims to investigate the correlation between impacted canines, transverse maxillary deficiency, and tongue posture affecting dental occlusion.

Materials and Methods: This in vitro study was conducted at the Department of Orthodontics and Dentofacial Orthopedics and the Department of Oral Medicine and Radiology. We included a total of 30 patients which were divided into 2 groups: group A (15 patients) with impacted canines and group B (15 patients) without impacted canines. In this study, Cone-beam computed tomography (CBCT) and lateral cephalograms were used to measure maxillary width and assess tongue posture. The analysis included ANOVA, post-hoc Scheffe tests, and multiple linear regressions.

Result: This study found no significant difference in mesiobuccal width (MAW) between impacted and non-impacted canines ($p = 0.43$). Although mesio-apical width showed a trend ($p = 0.08$) Pulpal mesio-buccal width (PMBW) showed no significant difference ($p = 0.20$), but pulpal mesio-apical width (PMAW) was significant ($p = 0.01$), suggesting pulp chamber dimension variations. Tongue posture differences weren't significant at L_1, L_2, and L_3, but at L_4 and L_6, impacted canines had lower postures ($p = 0.01$). At L_7, there was a significant difference ($p = 0.01$), indicating lower tongue posture in the impacted group.

Conclusion: Impacted maxillary canines may not significantly affect certain maxillary dimensions, such as crown and alveolar widths. However, they may influence tongue position and proximal maxillary alveolar width. These findings underscore the importance of considering impacted canines, as they show a potential impact on dental arch development and occlusal stability. We suggest future research with an effective sample size to further investigate these relationships.

Keywords: Impacted maxillary canines, Transverse maxillary deficiency, Tongue posture, Dental occlusion.

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1. Introduction

Impacted teeth are those that remain partially or fully embedded in the jawbone or soft tissue for over two years after they should have naturally erupted.[1] The maxillary canine ranks as the third most commonly impacted tooth following the maxillary and mandibular third molars, with a prevalence of 2%. It is more common in females than males.[2] Palatally impacted canines are primarily linked to two theories: growth and genetics, while dental crowding seems to be the main cause of labially impacted canines.[3]

Several factors contribute to the higher prevalence of canine impactions, such as the longer roots and eruption path of maxillary canines, their deep development in the jaw, and their sequential eruption after neighboring teeth. Conversely, mandibular canine impactions are notably less common than those in the maxilla. Genetic factors also play a substantial role in the development of maxillary canine impactions (MCIs).[4]

Tooth impaction significantly contributes to malocclusion. The permanent maxillary canines have the longest eruption path due to their developmental position,

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which is distant from the dental arch and close to the nasal cavity. Canines play a crucial role in supporting facial appearance, dental aesthetics, functional occlusion, and arch development.[5,6]

Transverse maxillary deficiency is typically identified early, between 8 and 10 years of age, while the eruption of maxillary canines usually occurs around 10.5 years in girls and 11.5 years in boys, with individual variations of 3-4 years.[7] Therefore, there could be a notable correlation between the transverse dimensions of the maxillary arch and canine impaction. The tongue plays a crucial role in positioning the dentoalveolar structures. Beyond its function, the posture, size, and shape of the tongue are also significant factors.[8]

Assessing impacted maxillary canines (IMCs) is essential in orthodontic treatment to prevent undesired outcomes and enhance cost-effectiveness. However, treating impacted maxillary canines is a significant challenge in modern orthodontics. Typically, treatment involves surgically exposing the impacted tooth and then using orthodontic techniques to guide it into its proper position in the dental arch. Complications such as bone loss, root resorption, and gingival recession around the affected teeth are common.[9]

The growth, posture, and function of the tongue play crucial roles in determining dentoalveolar morphology. Primozic et al.[10] indicated a positive correlation between the width of the maxillary arch and the posture of the tongue. Orthodontic diagnosis and treatment require precise assessment of impacted teeth and their effects on adjacent structures. Conventional radiographic methods often struggle with superimposition, hindering accurate evaluation.[11] Cone-beam computed tomography (CBCT) offers superior imaging, enabling detailed analysis of maxillary arch dimensions, alveolar bone morphology, and impacted tooth position. Therefore, this study aims to correlate impacted maxillary canines, transverse maxillary deficiency, and tongue posture using CBCT and lateral cephalograms.

2. Materials and Methods

This in-vitro study was conducted at the Department of Orthodontics and Dentofacial Orthopedics and the Department of Oral Medicine and Radiology. Ethical approval was obtained from the ethics committee before the study commenced. In this study, we included 30 patients aged between 20 and 30 years. Patients with a symmetrical face as evaluated by extraoral examination were included. Patients with craniofacial abnormalities, facial asymmetries where the lower facial midline does not align with the upper facial midline, mandibular deviations during opening or closing, temporomandibular dysfunctions, a history of prior orthodontic treatment, and history, signs, and symptoms of any parafunctional habits or unilateral chewing habits were excluded from the study.

These 30 patients were divided into two groups: Group A with impacted canines (15 patients) and Group B without impacted canines (15 patients). The 15 cone-beam computed tomography (CBCT) images of subjects with impacted maxillary canines and 15 CBCT images of subjects without dental impactions (control group), along with the lateral cephalograms of the same 30 subjects were analyzed.

The maxillary width was measured at four levels: first molar basal width, first molar alveolar width, first premolar basal width, and first premolar alveolar width using the previously obtained CBCT scans. Tongue analysis was performed by tracing the lateral cephalogram to determine tongue posture. Group comparisons were conducted using analysis of variance (ANOVA) and post-hoc Scheffe tests. The influence of group features on transverse dimensions was evaluated through multiple linear regression analysis. All CBCT images were acquired with the "Planmeca Promax3D imaging CBCT unit."

2.1. Statistical analysis

Statistical analysis was conducted using SPSS version 16 for Windows (SPSS Inc., Chicago, IL). Descriptive statistics were used to present quantitative data, expressed as mean and standard deviation. Data normality was assessed using the Shapiro-Wilk test. Intergroup comparisons of means among the three groups were performed using t-tests. The confidence interval was set at 95%, the probability of alpha error was set at 5%, and the study's power was set at 80%. The significance level was considered at p-value <0.05.

3. Results

In the present study, we aimed to evaluate the correlation between impacted maxillary canine, transverse maxillary deficiency, and the posture of the tongue. Understanding the relationship between these factors is crucial in orthodontic diagnosis and treatment planning, as they can significantly influence dental occlusion and facial aesthetics

Table 1: Intergroup comparison of maxillary first molar basal width (MBW), maxillary first molar alveolar width (MAW), maxillary first premolar basal width (PMBW) and maxillary first premolar alveolar width (PMAW) between Impacted and Non-impacted canine.

MBW	**N**	**Mean± SD**	**p-Value**
Impacted Canine	15	62.86 ± 3.23	0.43
Non impacted Canine	15	63.72 ± 2.70	
MAW	**N**	**Mean ± SD**	
Impacted Canine	15	58.74 ± 2.62	0.08
Non impacted Canine	15	60.43 ± 2.57	
PMBW	**N**	**Mean ± SD**	
Impacted Canine	15	39.43 ± 2.00	0.20
Non impacted Canine	15	40.45 ± 2.26	
PMAW	**N**	**Mean ± SD**	
Impacted Canine	15	42.48 ± 1.85	0.01
Non impacted Canine	15	44.38 ± 2.31	

From the **Table 1** we see that The MBW shows, no statistically significant distinction is found between impacted and non-impacted canines, with a p-value of 0.43. This suggests that the mesiobuccal width of the teeth is similar regardless of impaction status, with impacted canines measuring, on average, 62.86 ± 3.23, and non-impacted canines slightly larger at 63.72 ± 2.70.

Similarly, for MAW, although the p-value is 0.08, implying a potential trend toward significance, there is no conclusive difference between impacted and non-impacted canines. The mean MAW for impacted canines is 58.74 ± 2.62, whereas for non-impacted canines, it is marginally higher at 60.43 ± 2.57.

The analysis of PMBW indicates no significant distinction between the two groups, with a p-value of 0.20. This means that the pulpal mesio-buccal width of impacted canines (39.43 ± 2.00) is comparable to that of non-impacted canines (40.45 ± 2.26).

However, in contrast, the parameter PMAW exhibits a statistically significant difference between impacted and non-impacted canines, with a p-value of 0.01. This indicates that the pulpal mesio-apical width of impacted canines (42.48 ± 1.85) is significantly different from that of non-impacted canines (44.38 ± 2.31), suggesting potential variations in pulp chamber dimensions between the two groups.

Table 2 shows numerically denoted landmarks and their description used in measuring maxillary first molar basal width (MBW), maxillary first molar alveolar width (MAW), maxillary first premolar basal width (PMBW) and maxillary first premolar alveolar width (PMAW) between Impacted and Non-impacted canine.

Table 2: Labelling of the numerically denoted landkmarks shown in the table

No.	Landmarks	Definition
1	Molar Right/Left Nasal Floor	The most inferior point on the right/left side of the nasal floor at the level of maxillary first molars
2	Premolar Right/Left Nasal Floor	The most inferior point on the right/left side of the nasal floor at the level of maxillary first premolars
3	Right/Left Molars Buccal Cusp	The most inferior point of the right /left buccal cusps at the center of the maxillary first molars
4	Mid-palatal Point	The most inferior point of the oral floor of the palatal bone at the level of the maxillary first molars
5	Alveolar molar point	The most inferolateral point on the alveolar ridge opposite the center of the maxillary first molar
6	Alveolar premolar point	The most inferolateral point on the alveolar ridge opposite the center of the maxillary first premolar

Table 3: Represents the tongue posture at 7 different positions.

Parameters	Definition
L_1	Measures the length of the tongue in the posterior portion (root) of the tongue.
L_2	Indicates the partial length of the tongue in the posterior region of the dorsum.
L_3	Indicates the partial length of the middle part of the dorsum of the tongue
L_4	Indicates the partial length of the tongue in the middle of the dorsum of the tongue.
L_5	Indicates the partial length of the tongue in the middle of the dorsum of the tongue
L_6	Indicates the partial length of the tongue in the anterior region of the tongue
L_7	indicates the partial length of the tongue in the tip region

Table 4: Intergroup comparison of impacted and non-impacted canines at all positions with respect to tongue posture.

L_1	**N**	**Mean ± SD**	**p-value**
Impacted Canine	15	0.73 0.70	0.15
Non impacted Canine	15	0.28 0.94	
L_2	**N**	**Mean ± SD**	
Impacted Canine	15	7.33 ± 1.17	0.30
Non impacted Canine	15	6.46 ± 2.97	
L_3	**N**	Mean ± SD	
Impacted Canine	15	7.86 ± 1.06	0.16
Non impacted Canine	15	8.66 ± 1.91	
L_4	**N**	Mean ± SD	
Impacted Canine	15	8.33 ± 1.04	0.01
Non impacted Canine	15	12.40 ± 1.59	
L_5	**N**	Mean ± SD	
Impacted Canine	15	7.66 ± 0.81	0.09
Non impacted Canine	15	8.46 ± 1.59	
L_6	**N**	Mean ± SD	
Impacted Canine	15	6.06 ± 1.03	0.01
Non impacted Canine	15	7.80 ± 1.42	
L_7	**N**	**Mean ± SD**	
Impacted Canine	15	-.20 ± 0.86	0.01
Non impacted Canine	15	4.83 ± 0.83	

Table 3 shows different postures of tongue at different position based on the reference intergroup comparison of impacted and non-impacted canines at all positions with respect to the tongue positions in each group was evaluated.

Table 4 illustrates that at the L_1 position, the mean tongue posture is higher in the impacted canine group compared to the non-impacted group, although the difference is not statistically significant (p = 0.15). Similarly, at L_2 and L_3 positions, there were no significant differences observed in tongue posture between the two groups (p = 0.30 and p = 0.16 respectively).

However, significant differences emerge at the L_4 and L_6 positions. At L_4, the impacted canine group exhibits a lower tongue posture compared to the non-impacted group (p = 0.01), while at L_6, the impacted canine group again shows a lower tongue posture compared to the non-impacted group (p = 0.01).

At the L_5 position, although the difference in tongue posture between the two groups is not statistically significant (p = 0.09), there was a trend towards a higher tongue posture in the impacted canine group compared to the non-impacted group.

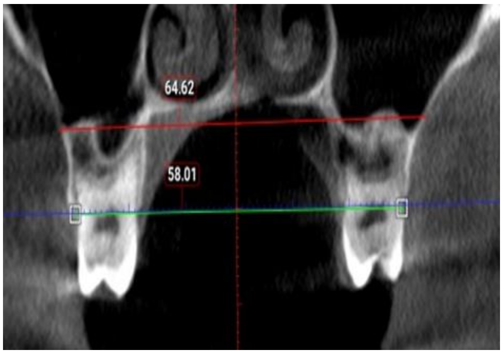

Figure 1: Nonimpacted canine- molar basal and alveolar width

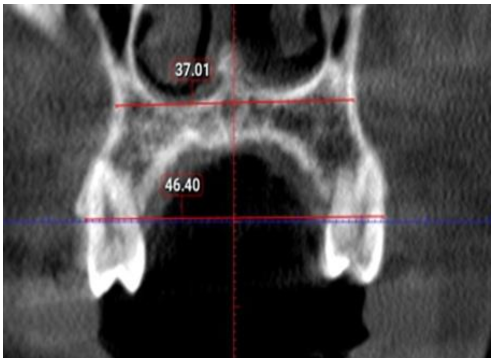

Figure 2: Nonimpacted canine- premolar basal width and premolar alveolar width

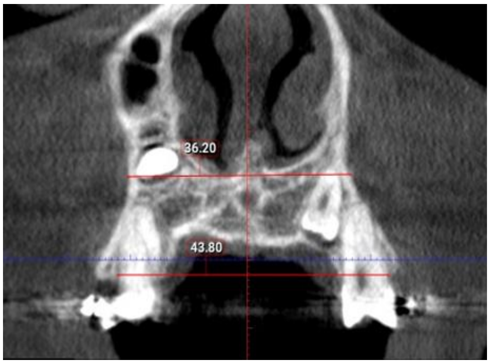

Figure 3: Impacted canine- premolar basal width and alveolar width

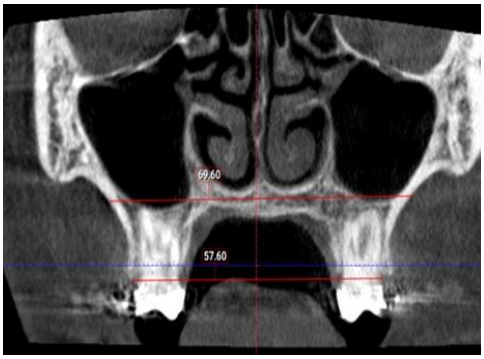

Figure 4: Impacted canine - molar basal and alveolar width.

The results show a notable distinction in tongue posture between the impacted and non-impacted canine groups at the L_7 position. The mean tongue posture in the impacted canine group was recorded as -2000, suggesting a lower tongue posture compared to the non-impacted group, which has a mean tongue posture of 4.8333. This difference is statistically significant, with a p-value of 0.01.

4. Discussion

Impacted maxillary canine is a common dental problem that dental professionals frequently encounter in their practice. For effective treatment planning and intervention, timely diagnosis of impacted maxillary canines is crucial. Early detection during childhood or adolescence allows for preventive and interceptive treatments like maxillary expansion and early removal of deciduous teeth, which are most effective at this stage. Failure to address impacted canines promptly may lead to complications such as cyst formation, root resorption, and malocclusion development.[12]

In this study, we compared the MBW of impacted canines with that of non-impacted canines. The mean MBW was 62.86 mm for the impacted canine group and non-impacted group the MBW value was higher i.e. 63.72 mm, with a lower standard deviation of 2.70 mm this shows the two groups were not statistically significant (p=0.43). The impacted canine group had a mean MAW of 58.74 mm and the non-impacted group had 60.43 mm, the difference was not statistically significant (p = 0.08).

This study also compared the PMBW in which the impacted canine group had a mean PMBW of 39.43 mm, while the non-impacted group had 40.45 mm. However, the difference was not statistically significant (p = 0.20). These findings suggest that impacted canines may not have a significant impact on certain maxillary dimensions.

According to a study done by Sharhan et al.[13] Significant differences were found in MBW and PMBW among the unilateral, bilateral, and control groups. The differences were smaller in the unilateral and bilateral groups compared to the control group (p < 0.001). The smallest difference was in MBW (3.3 mm) between the control (70.70 ± 4.52 mm) and unilateral (67.37 ± 5.75 mm) groups. The largest difference was in PMBW (8.7 mm) between the control (46.54 ± 7.39 mm) and bilateral (37.79 ± 8.88 mm) groups. There were no significant differences in arch depth among the three groups.

In this study, we found that tongue posture was higher in the impacted canine group compared to the non-impacted canine group at the L-1, L-4, L-6, and L-7 positions, which represents a lower tongue posture in the non-impacted group at these positions. However, there were no statistically significant differences in tongue posture between the two groups at the L-2, L-3, and L-5 positions.[14]

Primozic et al.[10] conducted a case-control study, in which they examined, the individuals with Class I and Class III malocclusions. They found that individuals with Class III malocclusions had a lower tongue posture compared to those with Class I malocclusions. Fatima et al.[14] stated in their study impacted maxillary canines may have a limited impact on certain maxillary dimensions but may influence tongue posture, particularly at specific positions. The results of their study underscore the importance of considering these factors in orthodontic treatment planning for patients with impacted maxillary canines, as they may affect the development of malocclusions and other oral health issues.

Shinde et al.[15] found that in Class II division 2 malocclusion, the tongue posture is more retracted and the tongue length is shorter compared to Class I. The middle portion of the tongue's dorsum is higher at rest in Class II Division 2 than in Class II Division 1. In Class I, the tongue is more anteriorly and superiorly placed in centric occlusion than in Class II division 1. In all groups, the tongue moves posteriorly and superiorly from rest to centric occlusion.

The position of teeth within the dental arch can be influenced by the pressure exerted by the surrounding lips, cheeks, and tongue. Changes in tongue position can lead to imbalances in these forces, potentially altering the shape of the dental arch. Studies have shown a weak or very weak correlation between tongue posture and dental arch width in individuals with skeletal Class I and II malocclusions. However, a moderate correlation was observed in skeletal Class III subjects, particularly at D3 and D4 in intercanine and intermolar width ratios, respectively.

5. Conclusion

Our study indicates that, there may not be a significant difference in the maxillary dimensions of impacted and non-impacted canines concerning MBW, MAW, and PMBW. Other research, however, has demonstrated that impacted canines can affect tongue posture, especially at specific locations, emphasizing the significance of taking these aspects into account when planning orthodontic treatment. Larger sample sizes and more studies are required to validate these results and thoroughly examine their therapeutic implications.

6. Source of Funding

None.

7. Conflict of Interest

None.

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